

US Patent Application No. 10/666,354
Reply to Office Action of March 1, 2006

REMARKS

Claims 1-34 are presently pending. Claims 35-52 are cancelled. Reconsideration of presently pending claims 1-34 is respectfully requested in light of the following remarks.

Rejections under 35 U.S.C. §102(b), Claims 1, 3, 5, 7-10, 12, 13, 15, 18-21, 23-25, 27, and 30-33

Claims 1, 3, 5, 7-10, 12, 13, 15, 18-21, 23-25, 27, and 30-33 are rejected under 35 U.S.C. §102(b) as being allegedly anticipated by Kim et al. (US Publication No. 2002/0106891 hereinafter referred to as "Kim"). This rejection is respectfully traversed.

The PTO provides in MPEP § 2131 that

"[t]o anticipate a claim, the reference must teach every element of the claim...."

Therefore, with respect to claims 1, 13, and 24, to sustain this rejection the Kim reference must contain all of the above claimed elements of the claim. However, contrary to the examiner's position that all elements are disclosed in the Kim reference, the reference does not disclose "performing a first treatment comprised of He plasma on said low k dielectric layer in a process chamber to form a transformed low k dielectric layer; and performing a second treatment comprised of H₂ plasma on said transformed low k dielectric layer in a process chamber."

The examiner alleges that Kim discloses these features in paragraphs 36 and 48, which read as follows:

Then, at the substrate 100 where the silicon oxycarbide layer 110 is formed, plasma treatment is performed to form a plasma-treated silicon oxycarbide layer 111. The plasma treatment can be performed by the in situ method in the PECVD chamber where the silicon oxycarbide layer 110 of the former step is formed. The process conditions can be similar to the case of forming the silicon oxycarbide 110 at the pressure of 10 Torr and a temperature of 300 to 400°C. As the plasma forming gas, there is one selected from the group of He, H₂, N₂O, NH₃, N₂, O₂, and Ar, or a combination of the above gases.

Referring to Figs. 5 and 6, after stacking the silicon oxycarbide layer 110, H₂ is supplied as a treatment gas for generating H₂-plasma, and the generated H₂ plasma is applied on the surface of the substrate 100 where the silicon oxycarbide layer 110 is formed. The treatment condition of H₂ plasma is preferably similar

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with that for forming a PECVD layer except for a source gas. For example, the H₂ plasma is performed under the conditions of a temperature of 250 to 400°C and a pressure of 1 to 10 Torr. Also, a radio frequency wave generating power of 13.6 MHz and 200 watts is applied at the substrate for 10 to 200 seconds in the CVD device which processes 8-inch wafers by single piece. The treatment time can be changed according to treatment condition of a subsequent process, but referring to an investigation with respect to characteristics of semiconductor devices formed, a silicon oxycarbide layer 111 whose surface is nearly saturated with hydrogen is formed through the treatment time of about 30 to 50 seconds.

However, in the above sections, Kim merely discloses performing a H₂ plasma treatment to the silicon oxycarbide layer to form a plasma-treated silicon oxycarbide layer. Kim does not disclose performing a second treatment of H₂ plasma to the plasma-treated silicon oxycarbide layer. Nowhere in the reference does Kim disclose that a second treatment of H₂ is performed after the first treatment of H₂ plasma.

The examiner alleges that in embodiment 4, Kim discloses a method of forming a layer of an organic polymer group over the regenerated surface of silicon oxycarbide layer to improve thermal and mechanical characteristics of a low k dielectric layer, and thus discloses the features of claim 1. However, Kim merely discloses, in paragraphs 62-63, that after the plasma treatment is applied, "the surface of the silicon oxycarbide layer is regenerated. A layer of an organic polymer group is formed over the regenerated surface. . . When the silicon oxycarbide layer and the organic polymer layer are continuously stacked to form an interlayer insulation layer, the exposed organic polymer layer is etched to form a trench for interconnection." Thus, instead of performing a second treatment of H₂, Kim discloses forming a layer of organic polymer after the treatment of H₂, and etching the exposed polymer to form a trench. Kim does not disclose the features of claims 1, 13, and 24.

Accordingly, Applicants respectfully submit that the rejection of claims 1, 3, 5, 7-10, 12, 13, 15, 18-21, 23-25, 27, and 30-33 are not supported by the Kim reference and should be withdrawn.

In addition, the examiner alleges that even though Kim is silent about the order of plasma treatment, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the sequence of Kim to include the first and second plasma treatments,

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because the final product of Kim appears to be similar to the product produced by Applicants claimed sequence of processing steps. Applicants respectfully disagree.

Kim fails to mention anything about performing a second plasma treatment of H₂ on the transformed low k dielectric layer. Kim merely discloses performing a single H₂ plasma treatment before forming a trench. Therefore, one of ordinary skill in the art would not have been led to modify the disclosure of Kim to include a second plasma treatment without some disclosure or suggestion by Kim. The examiner's allegation is erroneous in that Kim fails to disclose or suggest a second plasma treatment of H₂. Therefore, it would not have been obvious to one of ordinary skill in the art to modify the sequence of Kim to include the second H₂ plasma treatment.

Rejections Under 35 U.S.C. §103(a), Claims 2, 4, 6, 11, 14, 16, 17, 22, 28, 29, and 34

Claims 2, 4, 6, 11, 14, 16, 17, 22, 28, 29, and 34 are rejected under 35 U.S.C. §103(a) as being allegedly unpatentable over Kim in view of Grill et al. (US Patent No. 6,147,009 hereinafter referred to as "Grill"). Applicant traverses this rejection on the grounds that these references are defective in establishing a prima facie case of obviousness with respect to claims 1, 13, and 24 from which claims 2, 4, 6, 11, 14, 16, 17, 22, 28, 29, and 34 depend.

As the PTO recognizes in MPEP § 2142:

... The examiner bears the initial burden of factually supporting any prima facie conclusion of obviousness. If the examiner does not produce a prima facie case, the applicant is under no obligation to submit evidence of nonobviousness...

It is submitted that, in the present case, the examiner has not factually supported a prima facie case of obviousness for the following, mutually exclusive, reasons.

1. Even When Combined, the References Do Not Teach the Claimed Subject Matter

The Kim and Grill references cannot be applied to reject claims 2, 4, 6, 11, 14, 16, 17, 22, 28, 29, and 34 under 35 U.S.C. § 103(a). As discussed above, Kim does not disclose

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"performing a first treatment comprised of He plasma on said low k dielectric layer in a process chamber to form a transformed low k dielectric layer; and performing a second treatment comprised of H₂ plasma on said transformed low k dielectric layer in a process chamber," as recited in claims 1, 13, and 24, from which claims 2, 4, 6, 11, 14, 16, 17, 22, 28, 29, and 34 depend. Grill also does not disclose such features.

At column 2, line 60 to column 3, line 2, Grill discloses "a method for fabricating a thermally stable hydrogenated oxidized silicon carbon film can be carried out by the operating steps of first providing a parallel plate plasma enhanced vapor deposition chamber, positioning an electronic structure in the chamber, flowing a precursor gas containing atoms of Si, C, O, and H into the chamber, depositing a hydrogenated oxidized silicon carbon film on the substrate, and optionally heat treating the film at a temperature not less than 300°C." Thus, Grill merely discloses flowing a precursor gas containing Si, C, O, and H into a chamber to deposit a hydrogenated oxidized silicon carbon film and heat treating the film. Nowhere in the reference does Grill disclose or suggest a first treatment of He plasma on the film, let alone a second treatment of H₂ plasma on the film. Since neither Kim nor Grill discloses a second treatment of H₂ plasma, the references do not disclose the subject matter of claims 1, 13, and 24.

In addition, neither Kim nor Grill discloses "curing the low k dielectric layer before performing the He plasma treatment" as recited in claims 2 and 14. the examiner alleges that since Grill discloses heat treatment of film at a temperature not less than 300°C, it would be obvious to one of ordinary skill in the art to select curing of dielectric layer because Grill reveals that curing process improves stability of low k film. Applicants respectfully disagree. Since Grill fails to mention anything about a first or second plasma treatment, Grill does not and would not disclose curing the film before performing the He plasma treatment. Instead, Grill merely discloses optionally heat treating the film after the film is formed. Therefore, one of ordinary skill in the art would not have been led to cure the low k dielectric layer before performing the He plasma treatment, as alleged by the examiner.

Thus, for this mutually exclusive reason, the examiner's burden of factually supporting a *prima facie* case of obviousness has clearly not been met, and the rejection under 35 U.S.C. § 103(a) should be withdrawn.

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2. The Combination of References is Improper

Assuming, arguendo, that none of the above arguments for non-obviousness apply (which is clearly not the case based on the above), there is still another, mutually exclusive, and compelling reason why the Kim and Grill references cannot be applied to reject claims 2, 4, 6, 11, 14, 16, 17, 22, 28, 29, and 34 under 35 U.S.C. § 103(a).

§ 2142 of the MPEP also provides:

...the examiner must step backward in time and into the shoes worn by the hypothetical 'person of ordinary skill in the art' when the invention was unknown and just before it was made.....The examiner must put aside knowledge of the applicant's disclosure, refrain from using hindsight, and consider the subject matter claimed 'as a whole'.

Here, neither Kim nor Grill teaches, or even suggests, the desirability of the combination of "performing a first treatment comprised of He plasma on said low k dielectric layer in a process chamber to form a transformed low k dielectric layer," and "performing a second treatment comprised of H₂ plasma on said transformed low k dielectric layer in a process chamber," as specified above and as claimed in claims 1, 13, and 24 from which claims 2, 4, 6, 11, 14, 16, 17, 22, 28, 29, and 34 depend. Kim fails to mention anything about a second plasma treat of H₂. Kim merely discloses a single treatment of H₂ before forming a trench. Grill is merely interested in flowing a precursor gas comprising Si, C, O, and H into a chamber to deposit a hydrogenated oxidized silicon carbon film and heat treating the film. Grill fails to mention anything about a first or second plasma treatment. Neither reference discloses or suggests the desirability of the combination of a first treatment of He plasma to form a transformed low k dielectric layer and a second treatment of H₂ plasma on the transformed low k dielectric layer. In addition, neither reference discloses or suggests the desirability of curing the low k dielectric layer before performing the He plasma treatment, since Kim fails to disclose or suggest curing the silicon oxycarbide layer before the H₂ plasma treatment and Grill fails to mention anything about a plasma treatment, let alone curing the film before the plasma treatment.

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Thus, it is clear that neither reference provides any incentive or motivation supporting the desirability of the combination. Therefore, there is simply no basis in the art for combining the references to support a 35 U.S.C. § 103(a) rejection.

In this context, the MPEP further provides at § 2143.01:

The mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination.

In the above context, the courts have repeatedly held that obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention, absent some teaching, suggestion or incentive supporting the combination.

In the present case it is clear that the examiner's combination arises solely from hindsight based on the invention without any showing, suggestion, incentive or motivation in either reference for the combination as applied to claims 1, 13, and 24. Therefore, for this mutually exclusive reason, the examiner's burden of factually supporting a *prima facie* case of obviousness has clearly not been met, and the rejection of claims 2, 4, 6, 11, 14, 16, 17, 22, 28, 29, and 34 under 35 U.S.C. § 103(a) should be withdrawn.

Rejection Under 35 U.S.C. § 103(a), Claim 26

Claim 26 is rejected under 35 U.S.C. § 103(a) as being allegedly unpatentable over Kim in view of Grill and further in view of Wolf (Silicon Processing for the VLSI Era Vol. 1, page 441, Lattice Press (1986)). Applicant traverses this rejection on the grounds that these references are defective in establishing a *prima facie* case of obviousness with respect to claim 26. It is submitted that, in the present case, the examiner has not factually supported a *prima facie* case of obviousness for the following, mutually exclusive, reasons.

1. Even When Combined, the References Do Not Teach the Claimed Subject Matter

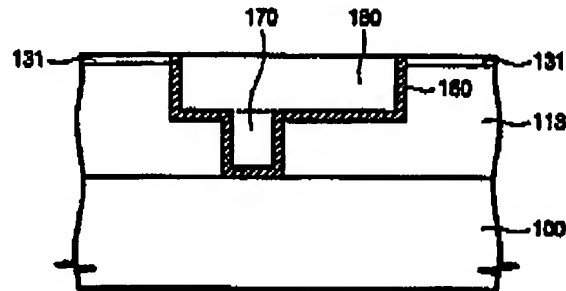
The Kim, Grill, and Wolf references cannot be applied to reject claim 26 under 35 U.S.C. § 103(a). None of the references discloses "providing a substrate with a metal layer

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comprised of metal lines having a top surface and sidewalls formed thereon and an anti-reflective coating (ARC) formed on the top surface of said metal lines" and "wherein said ARC is a TiN layer," as recited in claims 24 and 26.

The examiner alleges that Kim discloses the use of TiN a metal barrier layer (paragraph 52) without citing its use as a ARC layer, but Kim has discloses the use of TiN layer (paragraph 51) that can be used as ARC layer and that Wolf discloses the use of several ARC layer. Fig. 9 of Kim is shown below:

Fig. 9



In Fig. 9 and paragraph 52, Kim discloses that "[a] barrier metal pattern 160 is formed adjacent to the contact plug 170, the interconnection 180 composed of the metal layer, and the silicon oxycarbide layer pattern 113." Thus, Kim merely discloses a barrier layer that is adjacent to the contact plug. There is no mention of an anti-reflective coating that is formed on the top surface of either the contact plug 170 or the interconnection 180. To the contrary, Kim discloses in paragraph 52 that "the barrier metal layer and the metal layer for interconnection are removed, and a interconnection 180 and a contact plug 170 are formed." Therefore, Kim fails to discloses an anti-reflective coating that is formed on the top surface of the metal lines. Wolf also does not disclose such features.

On page 441, Wolf discloses that "[o]ne type of anti-reflective coating is a polymer film which is highly absorbing and non-bleaching at the exposure wavelength. It is applied directly to the substrate to a thickness of ~0.5 um, and resist is spun on top of it (Fig. 25)... Layers of

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ARC can also be used between the imaging resist and PMMA in multilayer resist processes." However, Wolf fails to mention an ARC that is formed on a top surface of the metal lines. Wolf merely discloses applying the ARC on the substrate. Therefore, Wolf also does not disclose the features of claims 24 and 26.

Thus, for this mutually exclusive reason, the examiner's burden of factually supporting a *prima facie* case of obviousness has clearly not been met, and the rejection under 35 U.S.C. § 103(a) should be withdrawn.

2. The Combination of References is Improper

Assuming, *arguendo*, that none of the above arguments for non-obviousness apply (which is clearly not the case based on the above), there is still another, mutually exclusive, and compelling reason why the Kim, Grill, and Wolf references cannot be applied to reject claim 26 under 35 U.S.C. § 103(a).

Here, Kim, Grill, and Wolf fail to teach, or even suggest, the desirability of the combination of "providing a substrate with a metal layer comprised of metal lines having a top surface and sidewalls formed thereon and an anti-reflective coating (ARC) formed on the top surface of said metal lines" and "wherein said ARC is a TiN layer," as specified above and as claimed in claims 24 and 26. Kim fails to mention anything about an anti-reflective coating on the top surface of the metal lines. Wolf merely discloses applying the ARC on the substrate. Neither reference discloses or suggests the desirability of the combination of an anti-reflective coating formed on the top surface of the metal lines and that the ARC is a TiN layer.

Thus, it is clear that neither reference provides any incentive or motivation supporting the desirability of the combination. Therefore, there is simply no basis in the art for combining the references to support a 35 U.S.C. § 103(a) rejection.

In the above context, the courts have repeatedly held that obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention, absent some teaching, suggestion or incentive supporting the combination.

In the present case it is clear that the examiner's combination arises solely from hindsight based on the invention without any showing, suggestion, incentive or motivation in either

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reference for the combination as applied to claims 24 and 26. Therefore, for this mutually exclusive reason, the examiner's burden of factually supporting a *prima facie* case of obviousness has clearly not been met, and the rejection of claim 26 under 35 U.S.C. §103(a) should be withdrawn.

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Conclusion

It is clear from all of the foregoing that independent claims 1, 13, and 24 are in condition for allowance. Dependent claims 2-12, 14-23, and 25-34 depend from and further limit independent claims 1, 13, and 24 and therefore are allowable as well.

An early formal notice of allowance of claims 1-34 is requested.

Respectfully submitted,



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